



## **Reproductive Anatomy and Physiology of Dairy Cattle<sup>1</sup>**

J. K. Shearer<sup>2</sup>

Optimal reproductive performance is fundamental to profitability of the dairy enterprise. Consequently, it is the focal point of dairy management and veterinary health programs on most successful dairy operations. When the average age of heifers at first calving is 24 versus 30 months, lifetime milk production potential is increased and replacement rearing costs decrease substantially. In cows, earlier conception following calving is rewarded by enabling cows to be dried off earlier. This results in fewer days dry and a higher average daily milk production. Efforts to attain these reproductive goals are consistent with progress toward the overall objective of achieving the maximum amount of milk yield per day of cow life.

There are, however, a multitude of factors which impede advancement toward the ideals of good reproductive performance. These vary from dairy to dairy. Retarded growth rates in heifers resulting from nutritional inadequacies, disease, and/or parasitism have a major impact on age at first breeding and subsequently, age at calving. Stress associated with parturition, increasing milk production, lagging dry matter intake, and negative energy balance in early lactation (<100 days) combine to enhance the susceptibility to both metabolic and infectious disease. Throughout the southern United States these

are further complicated by heat and environmental stress.

Consequently, reproductive problems in herds may be simple or multifactorial and complex. If the primary difficulties are associated with a few cows which may have a history of problems then the solution to the problem may be fairly simple: increase culling for reproductive reasons. On the other hand if the underlying causes are related to management, feeding, or nutritional factors, identification as well as problem-solving may be more difficult. An increase in the number of days to first breeding after calving lengthens calving intervals and is frequently a result of inadequate heat detection. Under most circumstances heat detection problems are related to observation failure. However, weather extremes, poor footing or slippery conditions, negative energy balance, and many other factors can influence the intensity of normal estrus behavior and make it more difficult to catch cows in heat.

In cases where estrus detection efficiency appears to be adequate but conception failure is the problem other factors may need to be considered. For example, infertility may be due to heat detection inaccuracies, poor semen quality, faulty insemination

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2. Associate Professor, College of Veterinary Medicine, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

technique, early embryonic death, reproductive tract infection, cystic ovarian disease, or other causes.

Finding the causes for reproductive inefficiency in specific herds often requires a thorough step-by-step investigation of all aspects of the reproductive program. For most herds many of these problems are averted by the establishment of reproductive health programs with a veterinarian. This arrangement affords an opportunity to identify, manage, or treat problems earlier, thereby limiting excessive losses in time and money.

Today's technological advances continue to provide a wide array of agricultural products for the livestock producer. One with specific importance to reproductive management on dairies is milk progesterone assay. While the dairy industry has heard of milk progesterone for many years, not until recently was it developed into a technique that is safe, easy to perform, accurate, and economical enough for daily on-farm use. Because milk progesterone is not a new concept and because it was originally touted as a pregnancy test in cattle, the introduction of these test kits to today's market has created some confusion and misconception.

A review of the basic anatomy of the reproductive tract and the estrus cycle will highlight some of the more important principles of sound reproductive health and management, and finally, provide some guidance to the reader on where milk progesterone assay may fit in the scheme of reproductive management of dairy cattle.

## **BASIC ANATOMY OF THE COWS REPRODUCTIVE SYSTEM**

The cow's reproductive system has four basic functions.

1. To produce ova (eggs) which provides half of the eventual offspring's genetic makeup.
2. To provide an environment and conditions for fertilization of those ova.
3. To provide a place following fertilization for the nourishment and fetal development of the calf.

4. To provide a mechanism for the birth of the calf.

Although it sounds quite straight forward and simple, in reality, nature has devised a very complex organ system to carry out these important functions.

### **Location of the Reproductive Tract**

The reproductive tract is located parallel to and just below the rectum of the cow. This location makes it convenient for examination purposes by palpation through the rectal wall. The entire reproductive tract including ovaries, oviduct, and uterus can be examined in this way, thereby providing a very valuable mechanism for the determination of the cow's reproductive status.

### **The Ovaries**

These are the primary reproductive organs. There are two, a right and a left ovary. They are approximately 1 to 1 1/2 inches long and about 1 inch thick and are located in a pouch-like membrane called the ovarian bursa. They are responsible for the secretion of hormones (estrogen and progesterone) and the production of fertilizable eggs.

Eggs begin their maturation in the ovary inside a fluid filled cavity lined with estrogen secreting cells called a follicle. Growth of these follicles is primarily regulated by the pituitary hormone, Follicle Stimulating Hormone (FSH). The cells which line the follicle and surround the egg continue to secrete estrogen in response to a rising level of another important pituitary hormone, Luteinizing Hormone (LH). The level of estrogen reaches a maximum level during the period of standing heat. Following a sudden surge in LH the egg is released from the follicle and ovulation occurs.

### **The Oviduct**

The oviducts are elongated tubes connecting the ovaries with the uterus. At the end nearest the ovary the oviduct is flared into a funnel shaped structure called the infundibulum. During estrus the infundibulum positions its finger-like projections around the ovary so as to guide the ovulated egg into the oviduct. Once in the oviduct the egg courses toward the uterus.

Assuming the cow has been inseminated, sperm cells will be migrating from the uterus toward the ovary around the same time the egg is entering the infundibulum and upper portion of the oviduct. Consequently, fertilization of the egg will occur in the upper region (first 1/3) of the oviduct.

### The Uterus

The uterus is Y-shaped consisting of a right and left horn both of which are connected to their corresponding oviducts. The junction of these horns forms the body of the uterus. The uterus serves to transport sperm cells to the oviduct and provide nutrients and the environment for the developing fetus. At calving the muscular wall of the uterus takes on the responsibility for expulsion of the calf.

**Table 1.** Stages of the bovine estrus cycle.

Stage	Cycle day	Duration	Events
Estrus	0	10-12 hr.	Mature follicle high levels estrogen LH surge
Metestrus	1-3	5-7 days	Ovulation (w/i 12-18 hrs) formation of CH no response to prostaglandin
Diestrus	5-18	10-15 days	Mature corpus luteum high levels progesterone
Proestrus	19-21	3 days	CL regressing maturing follicle rising estrogen

### The Cervix

The cervix consists of 5 muscular rings that form an impervious seal between the outside environment and the uterus during pregnancy. At calving the cervix relaxes and dilates to permit birth of the calf.

### The Vagina

The vagina connects the cervix with the vulva. It forms the birth canal during calving. It receives the penis and sperm from the bull during the course of natural breeding.

### The Vulva

The vulva is the visible external portion of the reproductive tract.

## THE ESTRUS CYCLE

Puberty is the period of time when the reproductive tract and secondary sex characteristics begin to experience rapid change and growth toward the mature adult form. This process may begin as early as 5 months old in the smaller dairy breeds and is usually complete in all breeds by 10 to 12 months of age.

### The Four Phases of the Estrus Cycle

Estrus is described as the time of increased sexual and activity and receptivity. Primary behavioral signs include standing when mounted by other cows, mounting other cows, vulvar swelling, restlessness, clear vaginal mucus discharge, and

bellowing. In cows this rhythmically occurs on average every 21 days. Estrus lasts approximately 18 hours with ovulation occurring around 12 hours after the end of standing estrus.

The estrus cycle is hormonally controlled and for purposes of understanding may be broken down into four phases: proestrus, estrus, metestrus, and diestrus. The proestrus and estrus periods are primarily under the influence of estrogen and are associated with growth of the follicle. Metestrus and diestrus are associated with growth of the corpus luteum and are primarily under the influence of progesterone (Table 1).

### Proestrus

The proestrus period occurs about 2 to 3 days prior to the onset of estrus in the cow and is characterized by follicular growth and estrogen (estradiol) production. Rising levels of estrogen

cause the blood supply to the reproductive tract to increase resulting in swelling of the entire tract. Glands of the cervix and vagina are stimulated to increase secretory activity yielding a thin vaginal discharge.

### **Estrus**

At the end of proestrus, estrus, the period of sexual desire, appears. These behavioral manifestations are a result of estrogens acting on the central nervous system. During this time the cow becomes very restless. She may bellow, lose her appetite, and drop off in milk production. Blood supply to the reproductive tract is increased and glandular secretion is stimulated yielding a clear viscid mucus which may be observed being discharged from the vulva. After about 14 to 18 hours these clinical signs of estrus begin to wane.

The cow is different from most other animals in that she has a very short period of sexual receptivity in which she accepts the bull or stands to be mounted by other cows. Further, cows do not ovulate until 12 to 16 hours after the end of estrus. Consequently, signs of estrus activity in cows can be easily missed, unless observed frequently.

### **Metestrus**

The period immediately following estrus (the period of sexual receptivity and activity) is metestrus. As stated above, the cow does not ovulate until after she goes out of estrus. Therefore, metestrus is the period in which ovulation occurs. As the egg is released from the follicle (the process of ovulation), blood and luteal cells fill the follicular cavity and begin to organize and develop to form the corpus luteum (CL).

Metestrus lasts only about 2 to 3 days. It is not uncommon to observe a blood stained mucus discharge during this period. It results from blood engorgement of the reproductive tract tissues which occurs during estrus. When observed it indicates that the cow was likely in heat 1 or 2 days before.

It is also during this time that the egg is being gathered in by the infundibulum of the oviduct and is beginning its course toward the uterus (roughly 5 to 7

days). Fertilization (union of the sperm and egg) will occur in the upper 1/3 to 1/2 of the oviduct.

### **Diestrus**

This is the most lengthy period in the estrus cycle. This is the period of corpus luteum function. As described above formation of a CL begins to occur immediately following ovulation. Whether pregnancy results or not, the CL will develop itself into a fully functional organ elaborating large amounts of progesterone. If a fertilized egg reaches the uterus, the CL will be maintained throughout the pregnancy. If, on the other hand, the egg which reaches the uterus is not fertilized the CL will remain functional only up to about day 17 or 18 after which time it will degenerate thereby permitting a new estrus cycle to be initiated.

In summary, the estrus cycle can be broken down into four phases: the estrogenic phases (proestrus and estrus) and the progestational phases (metestrus and diestrus). Estrogen dominates only about 4 days of the 21 day cycle, whereas progesterone dominates about 17 days. A fundamental understanding of the cow's reproductive cycle is essential to sound reproductive management. It is the basis for understanding where, when, and how to apply a technology such as milk progesterone assay.